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(54) Plate heat exchanger

(57) In order to weld together a stack of plates to form a heat exchanger, using laser beam welding, electron beam welding or similar processes entailing welding through the plate, the plates are formed, by appropriate through the plate welding, into sub-assemblies 1 and 21 with peripheral gaskets 8 and 23 respectively, with the peripheral gaskets 23 of the sub-assemblies 21 lying wholly within the line of the peripheral gaskets 8 of the sub-assemblies 1. This means that two sub-assemblies may then be welded together through the plate and the assembly built up in this way. The duct-forming apertures 3 and 4 of the sub-assemblies are alternately isolated from flow spaces by spacers 11 and 24 respectively. These spacers are also applied by through the plate welding and secured to the next plate by through the plate welding.

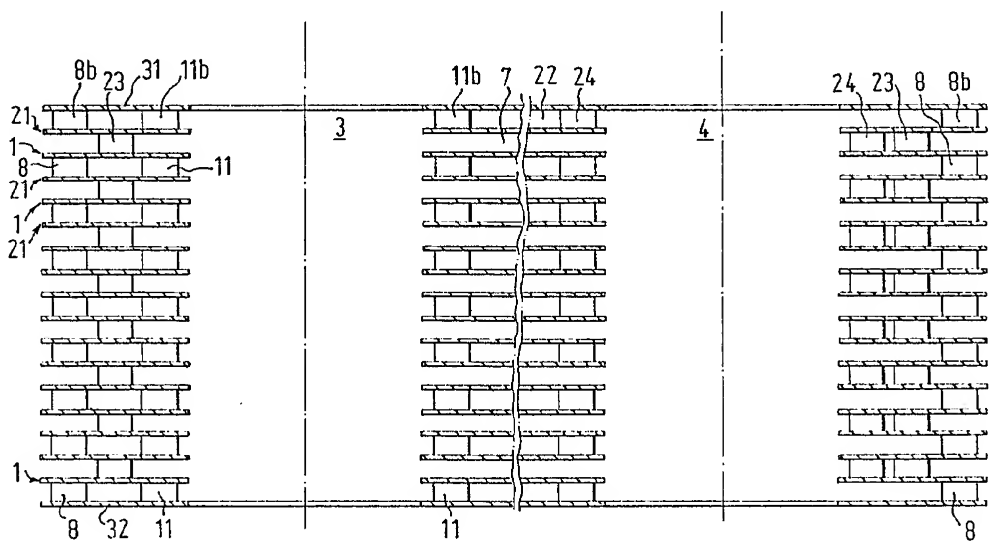

FIG.3.

GB 2 126 703 A

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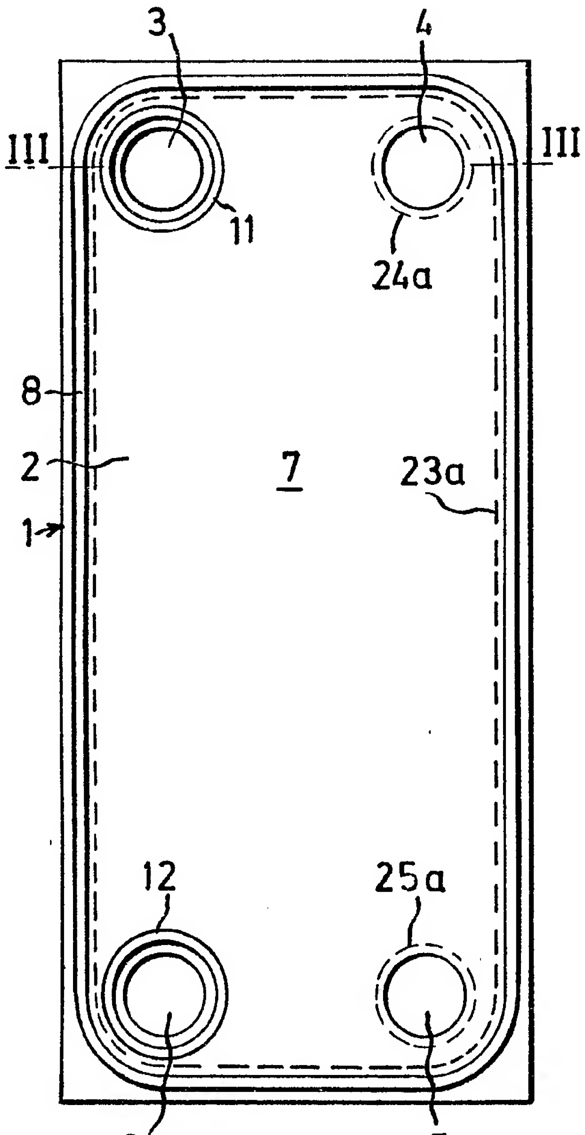

FIG.1.

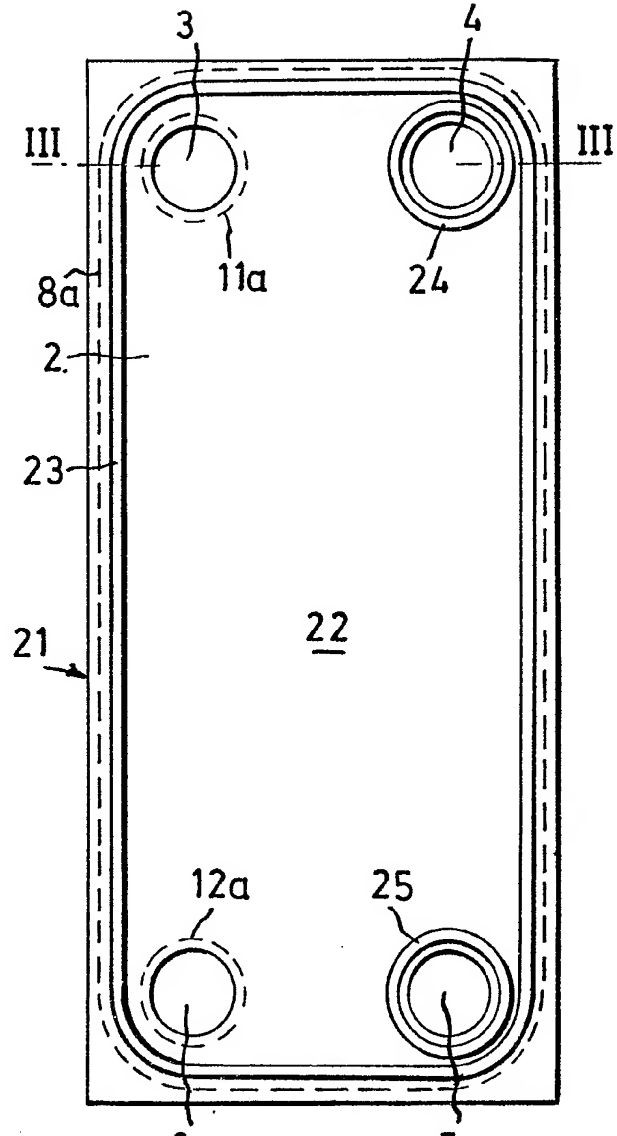

FIG.2.

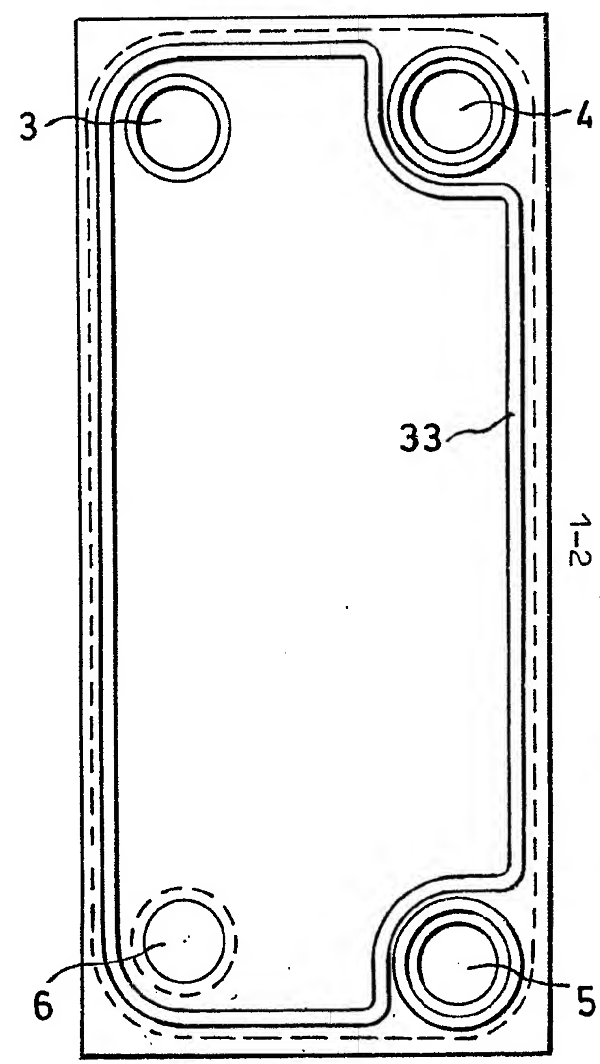

FIG.2a.

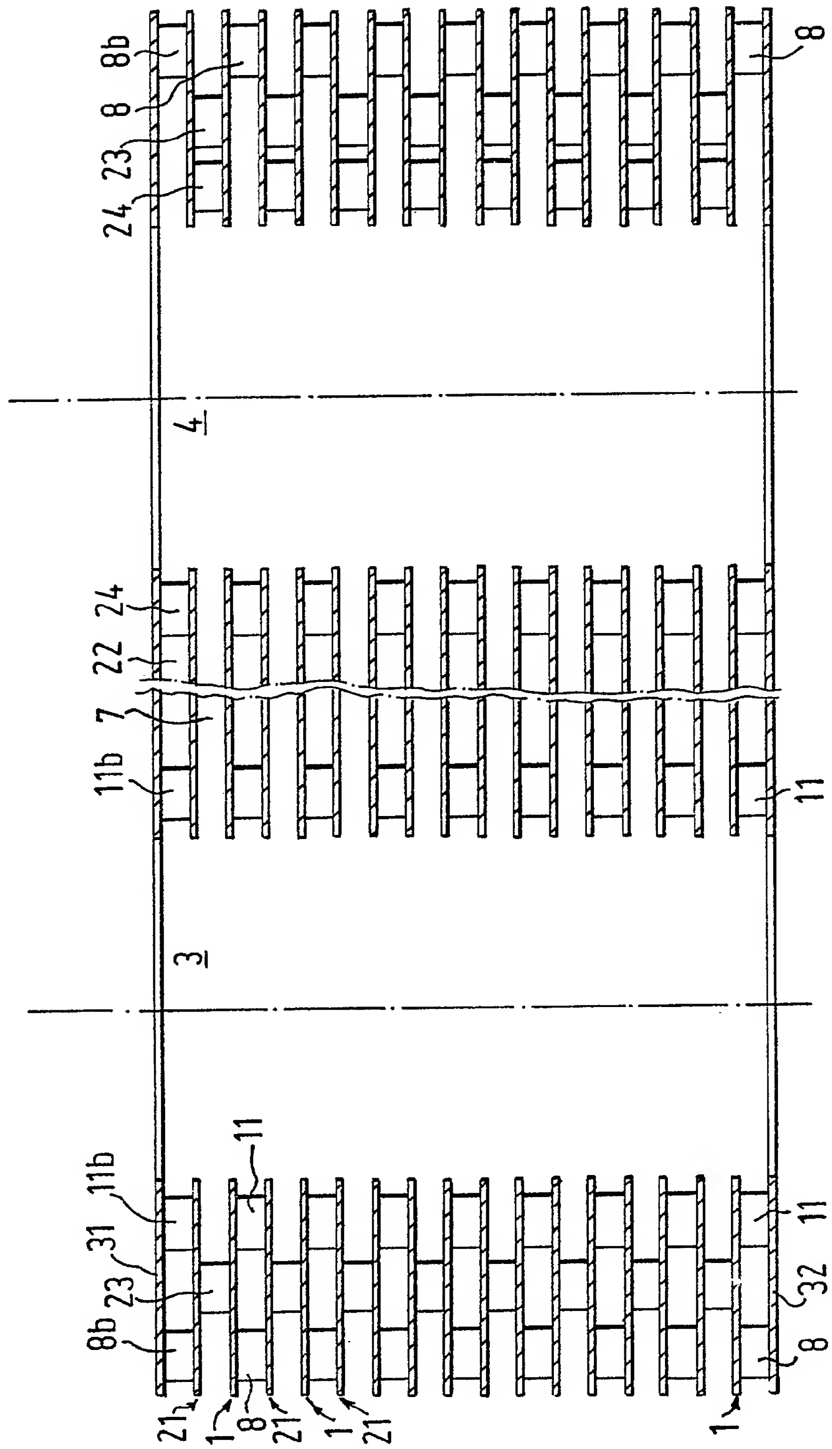

FIG.3.

SPECIFICATION
Heat exchanger

This invention relates to heat exchangers.

A plate heat exchanger consists of a pack of separable heat transfer plates arranged in spaced face-to-face relationship to define flow spaces between the plates. The flow spaces are defined and bounded by gaskets, usually of elastomeric material, mounted on the plates. Connections to the flow spaces are provided via aligned corner ports in the plates, which constitute supply and discharge ducts for two media to be placed in heat exchange and the gasketing also controls the flow of the media to the flowspaces such that one medium flows through alternate flow spaces and the other medium flows to the intervening flow spaces. The flow spaces may be, and usually are, provided with turbulence-promoting corrugations.

Such heat exchangers have acquired wide application and are commonly used in many industries. However, the use of gaskets does place a constraint on their use with corrosive or otherwise hazardous fluids, e.g. radioactive materials, since the gaskets may fail, particularly if subjected to corrosive fluids over a long period. Also, the gasketing need to be very vell supported if high operating pressures are to be used.

Accordingly, efforts are being put in to find a satisfactory heat exchanger made up from similar plates but welded together so as to use the good heat transfer characteristics of the plate heat exchanger, without the limitations applied by having elastomeric gaskets.

The welding in such cases needs to be very sound since if a welded-up heat exchanger of this type fails, repair is difficult if not impossible and the whole unit may need to be scrapped.

In order to achieve this sound welding it is proposed to use laser welding or electron beam welding for the assembly of such a heat exchanger. However, when assembling comparatively thick metal spacer strips (e.g. 3 mm thick) to the thinner plate material (e.g. 0.7 mm thick) these techniques are only usably with any certainty when welding through the plate, as opposed to welding through the thicker spacer.

In accordance with the present invention, there is provided a method of manufacturing a heat exchanger comprising a pack of plates welded into a pack in spaced face-to-face relationship to define flow spaces between adjacent plates, the plates having aligned apertures forming supply and discharge ducts for heat exchange media, in which two types of plate and spacer sub-assembly are formed by sealingly securing spacers to one side of the plates by welding through the plate, the sub-assemblies of a first type having a peripheral spacer extending on a line around the flow space and outside all of the duct-forming apertures, and aperture-sealing spacers surround one pair of the apertures to isolate those apertures from the flow space bounded by the peripheral spacer, the sub-assemblies of the second type having a peripheral spacer passing outside the apertures aligned with the said one pair of apertures in the sub-assemblies of the first type to allow these to communicate with the flow space and also having a pair of aperture-sealing spacers around the other pair of apertures to isolate them from the flow space, the lines of the peripheral spacers being such that, when a sub-assembly of one type is assembled next to a sub-assembly of the other type with the apertures aligned and only one set of spacers between the plates, the lines of the peripheral spacers do not intersect, and building up a stack of sub-assemblies by adding sub-assemblies of the different types alternately and welding through the plate to the spacers of the preceding sub-assembly to form continuous and sealing welds.

The welding of the sub-assemblies and the assemblies of the stack are preferably by laser welding, but electron beam welding may also be used.

It is to be noted that since the peripheral gaskets lie one inside the other, one peripheral gasket of each type may be cut from a sheet of material, e.g. by laser cutting.

The invention will be further described with reference to the accompanying drawings which show a preferred embodiment of the invention of one variation, and in which:—

Figure 1 is an elevation of a sub-assembly of one type;

Figure 2 is an elevation of a corresponding sub-assembly of another type;

Figure 2*a* shows an alternative to the sub-assembly of Figure 2; and

Figure 3 is an enlarged section on the line IV—IV of Figures 1 and 2 showing an assembled stack of plates.

The completed heat exchanger when manufactured in accordance with the invention consists of a pack of plates which are arranged in spaced face-to-face relationship and spaced apart and held together by being welded to spacers. The assembly of plates is illustrated in the sectional view of Figure 3 and Figures 1 and 2 each show a sub-assembly of plate and spacer of one type.

Turning first to Figure 1, this shows a sub-assembly 1 consisting of a plate 2 having the conventional corner apertures 3, 4 5 and 6, two of which are in communication with a flow space 7 formed between the plate 1 and the adjacent plate on one side and peripherally bounded by a spacer 8.

In accordance with normal practice, the flow space may be formed with corrugations of any suitable type to promote turbulence and heat exchange, and these may intermate with or cross and abut with corrugations on the adjacent plates. The actual form of the corrugations and flow space form no part of the present invention and need not be described in detail.

The spacer 8 extends outside all four apertures 3, 4, 5 and 6 and is welded to the plate 2 by laser welding or electron beam welding applied

through the plate, i.e. from the back of the plate as illustrated rather than from the illustrated side. The apertures 3 and 6 are surrounded by isolating spacers 11 and 12 respectively and these serve to isolate one medium from the flow space 7. Conversely, the apertures 4 and 5 are in communication with the flow space 7. The spacers 11 and 12 are also welded, through the plate, by laser welding or electron beam welding.

Turning now to Figure 2, there is shown a sub-assembly 21 of a slightly different type. It is again formed from a plate 2 having apertures 3, 4, 5 and 6 and has a flow space 22 surrounded and bounded by a spacer 23 extending outside all of the apertures 3, 4, 5 and 6 and also welded to the plate 2 by laser welding or electron beam welding through the plate. In the sub-assembly, the apertures 3 and 6 are in communication with the flow space 22 while the apertures 4 and 5 are surrounded by welded on spacers 24 and 15 respectively, again welded through the plate by laser welding or electron beam welding.

It is to be noted that the line of the spacer 23 falls wholly inside the line of the spacer 8 when the sub-assemblies 1 and 2 are assembled together with the corresponding apertures aligned, and also, the lines of these spacers 8 and 23 do not intersect the lines of the spacers 11, 12, 24 or 25.

The effect of this is that when a sub-assembly of the type 1 is superimposed upon the sub-assembly of the type 21, they may be welded together along a weld line shown dotted at 23*a* and corresponding with the line of the spacer 23 on the sub-assembly 2. This weld may thus be done through the plate. Similarly, the sealing of the apertures 4 and 5 from the flow space 22 may be completed by welding along the dotted lines 24*a* and 25*a* corresonding to the lines of the spacers 24 and 25.

In similar manner, a sub-assembly 21 may be welded to a sub-assembly 1 by welding through the plate along the dotted lines 8*a*, 11*a*, and 12*a* corresponding to the lines of the spacers 8, 11 and 12 on the subjacent sub-assembly 1.

In this way, a stack of plates may be built up, fully welded together by welding through the plate and yet having the advantages of the thin flat flow spaces and heat transfer characteristics of plate heat exchangers.

Although the peripheral spacers 8 and 21 are not aligned through the pack, this is of far less significance than in a plate heat exchanger in view of the fact that the assembly is welded together and therefore does not have to be compressed to effect sealing of the gaskets and their retention in gasket grooves.

Figure 3 shows a section through the apertures 3 and 4 of a pack or stack of such plates and somewhat thicker end plates 31 and 32. The end plate 31 is shown as having attached thereto a spacer similar to the spacer 8 as indicated by the reference numeral 8*b* and an aperture isolating spacer 11*b* similar to the spacer 11. These spacers are also welded on by a through the plate welding technique using laser welding or electron beam welding to form a sub-assembly, and to this sub-assembly there is attached a first sub-assembly of the type 21 having the peripheral spacer 23 and a spacer 24 isolating the aperture 4 from the flow space 22.

To this there is then assembled a sub-assembly of the type 1 having the peripheral spacer 8 and a spacer 11 isolating the aperture 3 from the flow space 7. The stack is then built up by further alternating sub-assemblies 1 and 21 as illustrated in Figure 4 and after the final sub-assembly the other end plate 32 is welded on by through the plate welding to the spacers of the final sub-assembly, which in the case illustrated are spacers 8 and 11 of the sub-assembly 1.

In the arrangement illustrated in Figures 1 and 2, the peripheral spacer 23, as well as the peripheral spacer 8 passes outside all four apertures 3, 4, 5 and 6. It may in certain circumstances be preferable for it to pass inside the apertures 4 and 5 as illustrated by the spacer 33 of Figure 2*a*. This will of course involve modification of the corresponding weld line in Figure 1 and it may also involve some re-design of the positioning of the apertures 4 and 5 which may then be moved somewhat nearer the edge of the plate, since only one peripheral gasket has to pass outside them rather than 2.

Various modifications may be made within the scope of the invention.

Thus, certain of the apertures 3, 4, 5 and 6 may in some sub-assemblies be unpunched so that multi-pass arrangements can be achieved.

Claims

1. A method of manufacturing a heat exchanger comprising a pack of plates welded into a pack in spaced face-to-face relationship to define flow spaces between adjacent plates, the plates having aligned apertures forming supply and discharge ducts for heat exchange media, in which two types of plate and spacer sub-assembly are formed by sealingly securing spacers to one side of the plate by welding through the plate, the sub-assemblies of a first type having a peripheral spacer extending on a line around the flow space and outside all of the duct-forming apertures and aperture-sealing spacers surround one pair of the apertures to isolate those apertures from the flow space bounded by the peripheral spacer, the sub-assemblies of the second type having a peripheral spacer passing outside the apertures aligned with the said one pair of apertures in the sub-assemblies of the first type to allow these to communicate with the flow space, and a pair of aperture-sealing spacers around the other pair of apertures to isolate them from the flow space, the lines of the peripheral spacers being such that, when a sub-assembly of one type is assembled next to a sub-assembly of the other type with the aperture aligned and only one set of spacers between the plates, the lines of the peripheral spacers do not intersect, and building up a stack

of sub-assemblies by adding sub-assemblies of the different types alternately and welding through the plate to the spacers of the preceding sub-assembly to form continuous and sealing welds.

2. A method as claimed in claim 1, in which the sub-assemblies are formed by laser welding.

3. A method as claimed in claim 1, in which the sub-assemblies are formed by electron beam welding.

4. A method as claimed in claim 1, 2 or 3, in which the sub-assemblies are welded together by laser welding.

5. A method as claimed in claim 1, 2 or 3, in which the sub-assemblies are welded together by electron beam welding.

6. A method as claimed in any of the preceding claims, wherein the peripheral spacers of one sub-assembly of each type are cut from the same sheet.

7. A method as claimed in claim 6, in which the spacers are cut by laser cutting.

8. A method of manufacturing a welded heat exchanger substantially as hereinbefore described with reference to the accompanying drawings.

9. A welded heat exchanger when manufactured by a method as claimed in any of the preceding claims.

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